COMPACT KIOSK-TYPE TRANSFORMER STATION GRÄPER
GBÜ-2000 (2TR)

Basic technical specifications:

- HV nominal voltage: 3 AC 22 kV 50 Hz
- LV nominal voltage: 3/PEN AC 420/242 V 50 Hz / TN-C,
- Frequency: 50 Hz
- Transformer nominal power: to **2x630 kVA** (1x1 600kVA)
- HV bus-bars nominal current: regarding HV distributor´s type to 630 A
- LV bus-bars nominal current: according to TR power to 2 500 A
- HV/LV distributor nominal insulation voltage: 24 kV / 1 000 V
- Nominal short-time/ HV distributor dynamic current: 16 kA / 40 kA
- Nominal short-time/ LV distributor dynamic current: do 25 kA / do 60 kA
- LV distributor cover: IP 20
- Whole station cover: IP 23D
- Temperature coefficient (cover class): K 20
- External dimensions (LxWxH): 3 050x2 500x2 650 mm
- Empty skeleton weight: cca 8 600 kg
- Environment: 3.1.1. basic (within the kiosk-type TS rooms),
  4.1.1. ambient, ordinary (outside the TS rooms)
- Exposure class: for internal components: XC1; for external components: XC4, XF1, XA1.
- Operating conditions: ambient temperature $-40°C \leq t \leq +40°C$
  altitude up to 1 000 m asl.

Note: If the transformer substation is used in different climate and operating conditions, the TS supplier is needed to be consulted.

Electrical current injury prevention:

(STN EN 33 3201, STN EN 33 2000-4-41),

- in normal operation mode (of the live parts): in HV system by: 4.1.1 – out of reach placement
  4.1.1 – live parts insulation
  4.1.1 – block, cover
  in LV system by: 3.7.1. live parts insulation
  3.7.2. blocks or covers
  3.8.5. out of reach placement (position)

– in case of failure (of dead parts): in HV system by: 4.2.5. automatic feed disconnection with quick IT networks disconnections to be off (with low imped. neutral TR grounding)

4.2.9. bonding – uniform potential installation
in LV system by: 3.2. automatic feed disconnection
3.6.1. additional protection by residual current device (TS install.)
3.6.2. additional protection – additional protecting bonding

Building part:

Externally controlled compact kiosk-type transformer substation is partially flush-mounted, with external dimensions of 3 050x2 500 mm, total height of 2 650 mm, clear height of 2 380 mm, ground sinking depth of 780 mm, over ground height of 1 870 mm (with flat roof). The construction is self-supported and standardly made of reinforced concrete Gräper LC 30/37, with granularity 8/12. Steel reinforcement frame composed of steel bars and mats is bilaterally welded and conductively connected together and takes part in the bonding, grounding, or even lightning protection system. The installation of the station skeleton does not require any foundations, but only a well flushed and rammed out cut. The transformer substation is type-approved, conforming to the STN EN 62271-202 norm and meets the resistance tests against internal arcing fault of the German PEHLA directive.

Optionally, the standard construction may be replaced by an insulated transformer station skeleton (e.g. for switchgears without transformer, or construction site buildings for the personnel). These may be constructed in two different versions:
1/ Sandwich construction composed of a self-supported three-layered construction made from lightweight reinforced concrete Gräper LC25/28 with wall thickness of 10cm, 4 cm thermal insulation layer of strengthened polystyrene foam (or 6 cm). And coating layer of lightweight concrete LC25/28 of 7 cm wall thickness.
2/ Standard construction made of lightweight reinforced concrete Gräper LC25/28 with thermal insulated facade constructed on site and made of thermal insulation layer of hardened polystyrene foam and structured plaster.

Station construction forms a compact unit consisting of two monolithic parts: basement tank with sidewals and a flat roof.
The basement tank and sidewalls: Made of waterproof and oil proof concrete (crack width up to 0.2 mm guranteed) as an oil catch tank. The construction resistance against strong chemical influence of the liquids, soils and vapours conforms to DIN directive. The tank serves as a foundation for the non-freezing part and for lifting the whole station by means of 4 anchorage points (sealed chasing nuts) RD 36, placed in the shorter sides of the TS (as viewed on „B“, „D“). In order to join the external grounding, two M12 points of HV/LV switchgear are led out from the sidewalls of the station. The bell casting method was used to construct the tank and door frames, thus creating a monolithic unit which meets requirements for the impermeability of water and oil substances. All surfaces of the transformer substation touching the ground and cable feeder entry and exit seals may be painted by two layers of black penetrating insulation paint, if required by the customer. The inside of the tank can also be treated by waterproof and impermeable paint.

HV and LV cable entry holes are made on production in the lower part of the body (HV or LV distributor´s side). After cable installation, the entry holes are sealed by Hauff press fittings (HSI 150 for the HV cables, HSI 90 for the LV cables)

Optionally, an inlet for the side pass of a temporary construction outlet (e.g. Gräper system or Hauff-BD) may be installed in the LV distributor space.

The entry opening for HV cables (cable space) is separated from the HV distributor with a steel plate. The distributor is placed on a steel construction including safety frame for the protection of maintenance personnel and personal protection agains internal arcing fault according to PEHLA standards.

Internal walls are standardly adjusted by white washable paint, surface treatment of the external walls, if wished so by customer, can be the following one:

- concrete with bare filler (exposed aggregate concrete) with 8/12 granularity,

- raw concrete in final finish colour according to the RAL palette of colours,

- from plastered concrete with material (scraped finish), or material Rollputz (plaster laid on by a roller), in final finish colour according to the RAL palette of colours,

- stone facing (for example Dupa-Stone), facing bricks, wood of other material as required by customer.

Roof: connected to the walls within inside, in 4 points by means of the screws and it laps over the walls contour by 10 cm. It is possible to lift the wall by means of 4 anchorage points (sealed chasing nuts) RD 18. In order to increase the protection of the concrete surface against humidity, the upper roof is completed by additional hydrophobic dustsheet, which obstructs capillary pores and thus works against hygroscopic properties of the concrete.
Surface treatment of the roof can be made of the concrete with bare filler (exposed aggregate concrete), or fair-face concrete with rough surface and paint according to the RAL palette of colours, the shape of the roof (terraced, saddle, cradle,) is optional as well

Door: all the metal parts like door, frames, and ventilating parts are standardly made of sheet steel galvanized on fire with width of 1,5 mm, basic paint and two layers of the finish paint in RAL 7032 palette of colours. The door is equipped with armour made up by external knob and internal handle with plastic cover of the lock and facility to fix up (arrest) the door in its open position under the angle of 95°. For arrestment – the locking, bob weights and point-to-point bars are used within each door wing frame (four- point locking system Gräper). The lock is adapted for standard lock inserts. The outer side of the door is covered by warning plates in terms of the valid EN.

Optionally, the door and ventilating parts can be made of anodized aluminium and 2 lock inserts can be used for double lockout.

The access to the HV and LV switchgear of the substation is provided by a common single wing door with full ventilation (slit shades Gräper with approved DIN 40 050 V2A safety level) with internal dimensions WxH of 1 270x1 610 mm, on the HV/LV transformer´s side there is a 2-wing door without ventilation (HV) and ventilation (LV) with internal dimensions WxH of 2 200x1 610 mm. The door is equipped with an arresting pawl for fixing in an open position and door wings are connected with the frame by a copper conductor with 16 mm^2 cross-section area.

Air exchange calculation: Gräper GKP – S1

1. For the Oil transformer **22 kV, 630 kVA Typ TOHn 378/22, BEZ „BA“**

- Transformer strain in summer time: 50 % - 60% of the nominal power
- Ambient air temperature: +35 °C
- no-load losses: Po = 1,3 kW
- load losses: : Pkn = 8,4 kW
- Ventilators altitude difference: h = 1,6 m

2. Calculation :

no-load losses: Po = 1,3 + 0,13 (10%) = 1,43 kW

load losses: Pk =8,4 + 0,84(10%) = 9,24 KW

N = 315 (50% of the nominal power)/630(100% of the nominal power) = 0,5

Total losses: Pz = Po + Pkn x N^2 = 1,43 +9,24 x 0,25 = 3,74 kW

Heat losses for ventilation calculation: Pch = 0,6 x Pz = 0,6 x 3,74 = 2,244 kW

Ventilator diameter in m^2 :

- Inlet : Sp = 0,1942 x (Pch/√h) = 0,1942 x (2,244/√1,6) = **0,345 m^2**
- Outlet : So = 0,2007 x (Pch/√h) = 0,2007 x (2,244/√1,6) = **0,356 m^2**

2x Transformer 630 kVA :

Ventilator diameter in m^2 :

- Inlet : Sp = 2 x **0,345** **= 0,69 m^2**
- Outlet : So = 2x **0,356** **= 0,356 m^2**

Air vents in the transformer station GBÜ :

- Inlet vent: 1250 x 1605 mm² = **2 m²** - TS door
- Outlet vent : 1250 x 1605 mm² = **2 m²** - transformer space

Outlet vent : 2200 x 1605 mm² = **3,5 m² -** door near to HV switchgear

Air exchange: Air vents for the transformer space in the entrance door and in the LV distributor door. The vents´ dimensions are designed to provide for a sufficient air ventilation and transformer cooling. Air vents are equipped with grid (lamellas - blinds Gräper with the level of protection following DIN 40 050 V2A) and net against foreign bodies (insects).

Grounding:

Composition of the TS internal grounding:

- **bonding bar** (BB) Cu 30x4 mm with M12 clips, located on the spreader insulator 1 kV, which is directly connected with all the technological components of the TS (vessel of the TR distributors tanks of the HV, LV, metal shield of the HV cables, branch bar PEN) and with individual installed components (construction components – tank and roof reinforcement, frames, door, grate, conducting „U"- beams of the transformer, bearing structures of the distributors...) using the Cu conductor with S_{min} 30 mm^2. Each conductor of the grounding connected to the BB is labelled.
- **earth artery** implemented by strip conductor Fe with S_{min} 125 mm^2, being part of the TS reinforcement and it is cast directly in the external walls and kiosk´s beam which serves as the connection of the common points of the grounding. Flexible parts are connected to the frame with copper (Cu) strip or Cu grounding cable with min. cross-section area of 16 mm^2.
- **2 nodes of the grounding feeder** by Hauff HDE-M12/X to connect the external grounding (in general FeZn stripe 30x4 mm) to the bonding bar (from the internal part of the node by a connecting screw M12-St 37 Zn, from the external part of the node through **test clips** of the **SZ1, SZ2** grounding with screw M12). Grounding feeder nodes are generally lead out of the opposite sidewalls of the station space for HV and LV distributor.

The transformer substation in standard finish does not have external lightning protection system, as it is a ground object mostly located close to other higher objects. All the metal reinforcement built-in to the corresponding parts of the TS (roof, walls, false ceiling, basement tank) are welded into a single unit using Parts of the skeleton are welded together using conducting joints (e.g. Cu lines 35 mm^2) thus forming Faraday´s cage and after roof mountaing is mounted they are fully connected to the grounding. If customer wishes otherwise, it is possible to equip the transformer substation with external lightning rod with one collector and two wires connected to the common TS grounding via test clips in terms of the valid STN.

For each transformer station a common grounding system for HV and LV facilities must be constructed. Its design needs to take into account the operating conditions – fault current value of the distribution network in the given region, power transformer node operation mode and local soil conditions (STN EN 33 3201, STN EN 33 2000-5-54,PNE 33 2000-1)

Installation:

The internal installation of the station includes interior lighting, comprised of oval incandescent 60 W lamp fitting with gate switch lighting in the distributor´s space of high and low voltage and in the transformer space and a one-phase socket of 230 V. The circuits feeding the lighting and socket

installation are led out from the main LV distributor via installation breakers, or combined with residual current circuit breaker.
Further equipment – as specified by customer.

Internal space of the TS is horizontally divided by concrete floor into three compartments: transformer space, chamber for the HV and LV distributors. The over ground part of the TS is composed of a common space, divided by the supporting technological structures and internal equipment into 3 separated compartments.

Transformer:

Oil, hermetic or dry-type transformers up to the power of 2x630 kVA, or 1x1600kVA may be commonly used in the substation, placed on vibration absorbers made by Gräper. In case of oil leakage the seat of the transformer is designed as an impermeable oil catch tank. If the transformer is sitting on wheel tray, it can be fixed against side movement. Transformer insertion and removal can be performed by crane if roof is removed. Max. dimensions of a single TR up to 630 kVA are (LxWxH) ca 1 250x1 000x 2 100 mm, TR up to 1600 kVA (LxWxH) ca 2 100x 1 250x 2 100 mm.
Transformer cooling is atmospheric. Air renewal is provided by air vents in the transformer door (on both the transformer's and HV and LV distrubtor sides) and in the TR chamber sidewall in case of a single TR.
The transformer´s protection against over current, or shortcut is provided:
a) HV side – by plugs or by switch with safety relay
b) LV side – by air breaker
Note: Because of the limited dimensions of the TR it is not allowed to use some types of TR 630kVA (e.g.BEZ – BA TOHn 378)

High voltage distributor:

In this transformer substation it is possible to use all the types of the commonly produced covered HV gas insulated distributors SF6 (for example GA, GA-C by Moeller, 8DJ10, 8DJ20 by Siemens, RM6 by Merlin Gerin,...), or type-approved vacuum distributors up to the width of 6 fields. Depending on type used, the nominal current of the distributors is up to 630 A, shortcut resistance (nominal short-time withstand current 1 s) to 20 kA, optionally up to 25 kA. The HV distributor may be delivered by the customer or by Gräper company, including the zinc-coated supporting construction and a construction for decreasing pressure in the arcing fault in the HV distributor conforming to PEHLA standards. Max. dimensions of the HV distributor are ca: 2 100x1 600x850 mm.

Low voltage distributor:

The panel version of the LV distributor is covered with IP 20. The feeder is equipped with air breaker depending on the transformer´s power. Outlets are equipped with breakage bar switches (in total 20 outlets for two TR with switches up to 400 A and construction width of 100 mm for one TR, or adequate number of outlets with switches up to 160 A and construction width of 50 mm), or breakers with attachment of cables with max. cross-section area of 300 mm^2. Nominal current of the distributor is standardly to 1 500 A, shortcut resistance (short-time nominal withstand current 1 s) up to 25 kA. Besides this, the distributor can include electricity consumption monitor, circuits for station lighting and service socket. The clips can be grounded on the main breaker´s feeder („ball pivots“) ∅ 25 mm, which allow to protect the working place during maintenance of the LV distributor via grounding

system (shorting set). Max. dimensions of both LV distributors (WxLxH) are ca: 2 100x 1 500x400 mm.

Note: The number of LV outlets is limited by customer´s demands for additional LV distributor equipment such as monitors etc.

The distributors meet the STN EN 60439-1 norm and also DIN VDE 0660, part 500, VDE 0100, VDE 0414, UVV standard requirements.

Cable connections:

They include HV distributor connection with transformer 24 kV by single-core cables 24-N2XSY 3x1x35 mm^2 and LV distributor connection with transformer 1 kV by cables 1- NYY-O 1x150 mm^2, or 1x240 mm^2.

Cable connections for high voltage are checked in each production phase. Filed tests of the TE fractional discharges in Gräper company´s own test-room can be carried out , following VDE 0434, VDE 0472 technical norms. According to the regulations the maximum allowed value for TE is ≤ 20pC. The real achieved value is ≤ 5 pC.

Station construction specifications

The station is constructed according to the norms and rules of STN EN, DIN, UVV etc., directly following the bellow given normative standards:

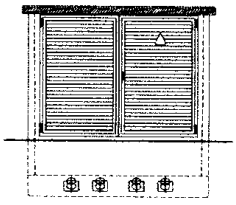
Cellular concrete	- DIN 4219
Reinforced concrete	- DIN 1045
VDE directives	- DIN 0141, 0101, 0100
Directive on the protection of ground waters	- GwSchV
Federal directive on waste disposal	- BimSchV
Electromagnetic radiation compliance	- BimSchV n.26

Individual structural components of the transformer substation are made of uninflammable materials, fire resistance of the station construction meets STN 73 0821 norms (fire resistance class required is F90, class documented is F120).

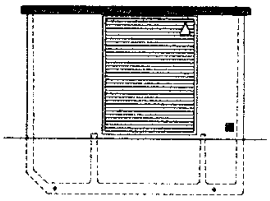
Delivery, assembly, ground cut for station placement:

The kiosk-type transformer station is delivered assembled and prepared for HV, LV cable connection and grounding. It is installed by crane into a prepared pit with compressed and flat surface according to the design project of the transformer substation´s producer – Gräper company (dimensions of the ground cut : 365x310 cm, cutting depth: 98 cm, compressed layer thickness: min. 20 cm).

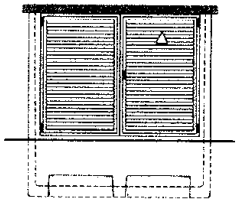
Views:



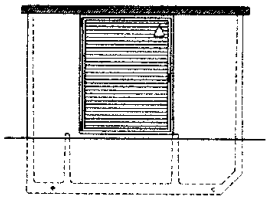
View „A“
(side of HV switchgear)



View „B“



View „C“
(side of LV switchgear)



View „D“
(side of the TR)